

# JOURNAL OF SOUTH AFRICAN BOTANY

## VOL. IV.

---

### THE UTILITY OF AERIAL PHOTOGRAPHS AS AN AID TO BOTANICAL SURVEY.

(With Plates 8—10)

By P. E. GLOVER, M.Sc.

*Department of Botany, University of the Witwatersrand.*

#### CONTENTS.

	PAGE
Introduction : the Area studied .. .. .	25
Geology of the Region .. .. .	36
Topography of the Region .. .. .	37
Main Types of Flora—	
(a) Grassland .. .. .	38
(b) Protea Other Spp. Open Woodland .. .. .	41
(c) Acacia Other Spp. Scrub .. .. .	41
Conclusions .. .. .	42
Summary .. .. .	43
Acknowledgments .. .. .	44
Bibliography .. .. .	44

#### INTRODUCTION.

During the year 1936 a number of excursions were made by Professor John Phillips and several of his students to the farm Blyvooruitzicht No. 71 near the town of Oberholzer on the West Rand.

With the aid of aerial photographs kindly supplied by Captain Robbins of the Aircraft Operating Company, investigations upon the ecology of the flora in relation to the geology and other factors of the region, were made.

One of the main objects of these investigations was to test the utility of aerial photographs as an aid to Botanical survey. At first sight, difficulty was encountered in recognising the different geological types and their relationship to the flora, but with the aid of Mr. N. Thammi who has mapped that region in great detail for the West Witwatersrand Arcas, Ltd., a fair degree of accuracy in recognising these types, and the accompanying plant communities upon them, was soon attained. In fact the aerial photographs were found of infinite value in estimating the comparative age and advancement of plant succession upon cultivated sites, overstocked sites, localities of native kraals, and roads and paths. Scrub types such as *Protea* other species open Woodland, *Royena*, *Rhus*, *Celtis*, *Zizyphus* and *Acacia* communities were easily discerned after a little practice, and in several instances it was found possible to guess the species of individual trees from the photographs.

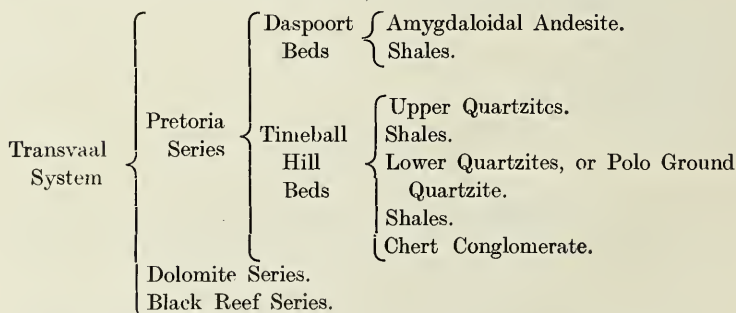
Exotic trees such as *Eucalyptus* spp. and *Black Wattles* were easily picked out from the photographs since they were usually planted in straight lines.

One of the chief objections to the use of aerial photographs is that cloud shadows on them give a false impression as to the type of country being studied. This, however, is not of great importance in the present investigation since only a few of the photographs have shadows upon them.

### THE GEOLOGY OF THE REGION.

The region is on what is known as the "Transvaal System."

This system is made up of the following series :—



The scope of the paper is confined to the Dolomite and Pretoria Series.

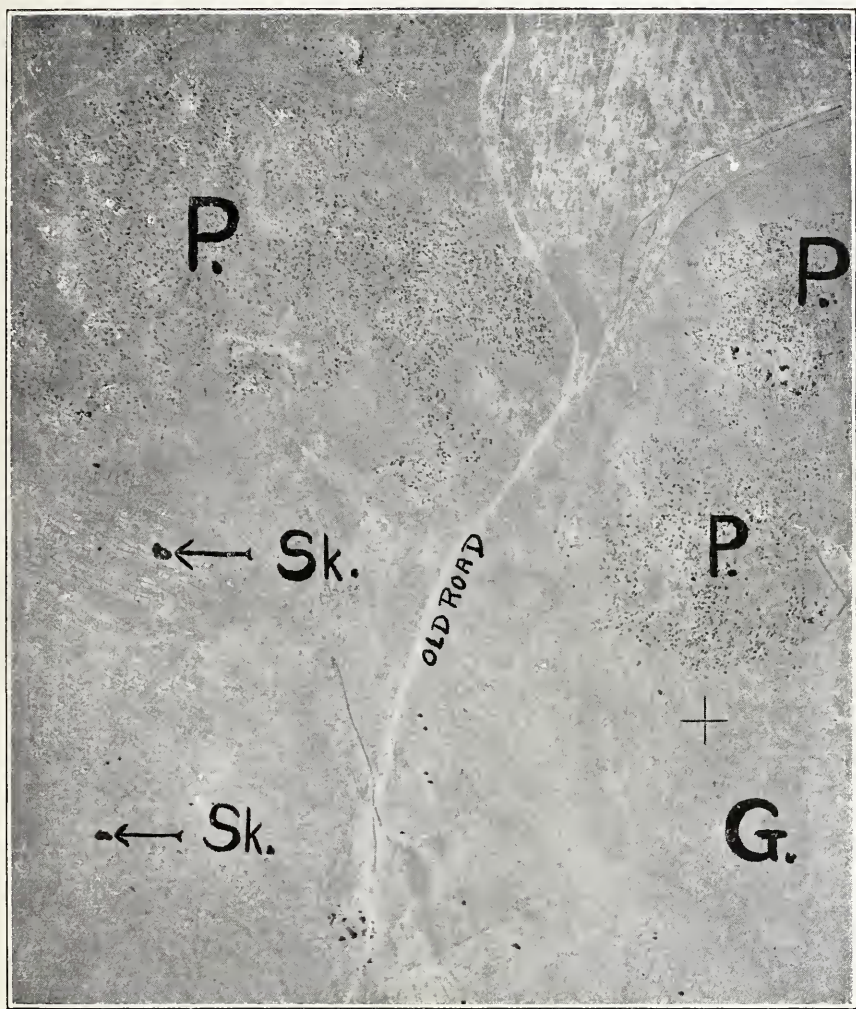


PLATE 8.

G. = Undisturbed Veld. Sk. = Sinkhole. P. = Protea.

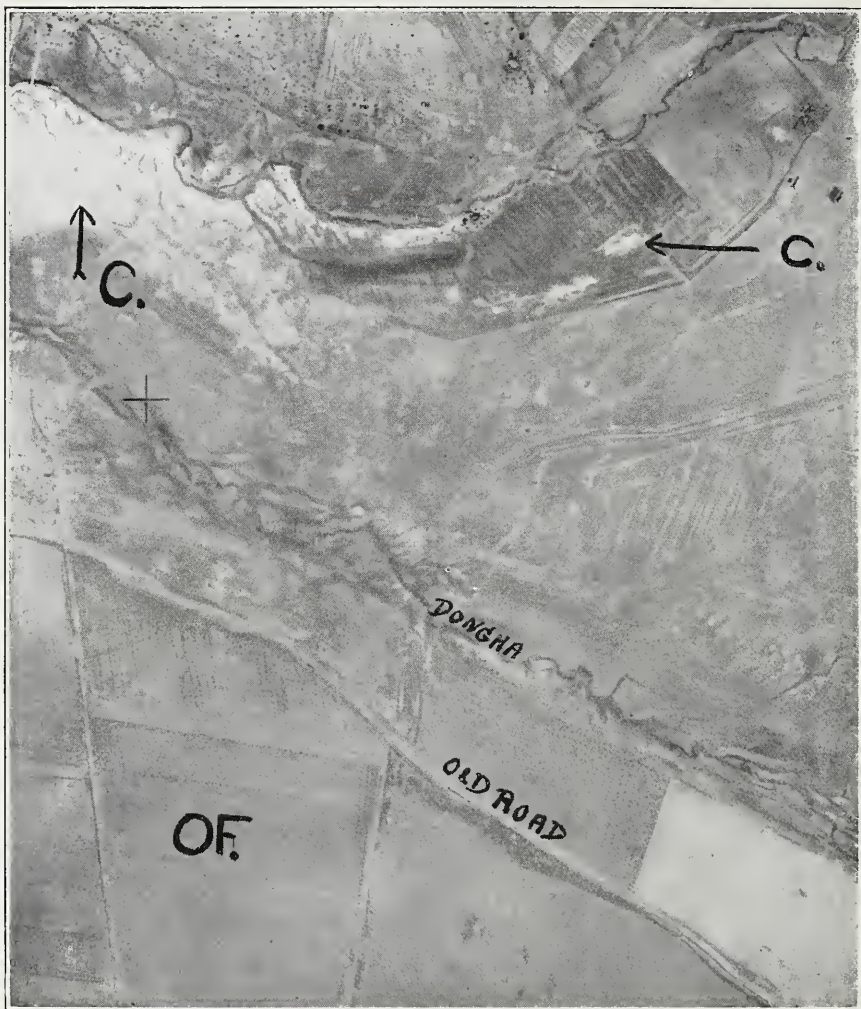


PLATE 9.

C. = *Cynodon Dactylon*. OF. = Old Fallows.



### **The Dolomite Series.**

This series usually comprises more or less flat undulating country, broken here and there by an outcrop of a quartz vein or a lens of chert. Sinkholes are common in the dolomite, and are usually marked by a clump of trees, such as *Cellis kraussiana*, *Olea verrucosa*, *Zizyphus mucronata*, *Rhus* sp. and *Royena pallens*.

### **The Timeball Hill Beds.**

#### *(a) The Chert Conglomerate.*

Just above the Dolomite is a Chert Conglomerate which looks as if it could more correctly be called breccia, on account of the erratic size and angularity of the pebbles. This Chert Conglomerate usually outcrops as small "koppies."

#### *(b) Lower Quartzite or Polo Ground Quartzite.*

Between the Chert Conglomerate and the Polo Ground Quartzite is a shale band, which varies considerably in thickness.

The Quartzites are a greyish-brown colour, are coarsely granular, and weather by breaking up into large more or less square boulders. As the weathering advances, the cracks between these boulders widen and deepen, and grasses and bushes grow out of them. The Polo Ground Quartzites often outcrop as low-lying hills. Sinkholes are common in the Quartzites and it is not unusual for the hills described above to have sinkholes in the middle of them, giving them a crater-like appearance.

These sinkholes are probably formed by the collapse of the overlying beds into caverns in the Dolomite made by the underground water. Above them lies another band of shales, and then the upper Quartzite of the Timeball Hill Series.

## **THE TOPOGRAPHY OF THE COUNTRY.**

To the North lies a broad flat valley, running approximately east to west. On the Southern side of the valley is a ridge of hills which comprise the Timeball Hill group of the Pretoria Series. (It was in this region that most of the work embodied in the paper was carried out.) To the South of the ridge is another valley running parallel with the ridge, and after this valley comes another higher ridge of hills.

An extract from the booklet supplied with the Geological map of the region made for the Department of Mines, ought to elucidate the above description :

"In the south-east the more or less east-westerly trending range of the Gatsrand with its comparatively steep northerly escarpment

slope, constitutes an imposing physical feature in the area under review. From any point on one of the many projecting spurs of this range, an open view can be obtained of the Dolomite country at some distance towards the north, while in the foreground rounded rises formed by the uppermost chert in the Dolomite Series are clearly visible. From the railway line in the neighbourhood of Welverdiend, and Bank Station, the reverse aspect of the country presents itself. There is a rise, at first gradual, from the low-lying Dolomite plain up to the chert hills, and the terracelike feature of the shales and diabase at the base of the range, and then suddenly a more rapid rise culminating in the rough escarpment of the Gatsrand proper. Whereas the highest ridge is generally formed of the uppermost quartzite of the Timeball Hill stage, occasionally, the diabase intrusive into the sedimentary beds gives rise to crescentic peaks standing above the general level. Towards the south, the gentle dip slopes of the quartzite composing this ridge, generally thickly covered with sugar bush, die out in a more or less longitudinal depression underlain by shales, and having as a southerly margin the rounded hogsback hills of Amygdaloidal lava. Beyond these in a southerly direction one crosses the ridge of the Daspoort Quartzite, generally not prominent compared with those of the lava; and the Gatsrand before descending towards the valley of the Loop Spruit in the neighbourhood of Fochville." (J.W.)

The mean annual rainfall on Wonderfontein, the adjoining farm to the north is 24·18 inches.

#### THE MAIN TYPES OF FLORA OF THE REGION.

1. *Grassland including Disturbed Sites such as Old Cultivated Lands.*
2. *Protea Other Species Open Woodland.*
3. *Acacia, Rhus, Royena Other Species Scrub Types.*

##### 1. GRASSLAND.

This may again be subdivided into the following types:

(a) **More or less undisturbed grassland**, on the flatter, less stony country, such as the Dolomite region.

The cover is low, approximately 10 per cent., but the species are good, and the soil is much richer than the granite soil on Frankenwald. The regions are recognised on the photographs as evenly coloured homogeneous areas.



PLATE 10.  
Ac. = Acacia Scrub. O.F. = Old Fallows.

The more abundant species are :—

*Grasses :*

*Andropogon amplexans*  
*Alloterpis semialata*  
*Brachiaria serrata*  
*Cymbopogon plurinodis*  
*Diplachne biflora*  
*Elyonurus argenteus*

*Eragrostis chalcantha*  
*Heteropogon contortus*  
*Monocymbium cerasiforme*  
*Schizachyrium semiberbe*  
*Themeda triandra*  
*Urelytrum squarrosus*

*Other Angiosperms :*

*Acalypha angustata*  
*Asclepias stellifera*  
*Becium hians*  
*Buphane tozicaria*  
*Cassia minosoides*  
*Dicoma anomala*  
*Elephantorrhiza elephantina*  
*Euphorbia truncata*  
*Gazania pygmaea*  
*Gnidia caffra*

*Gnidia cano-argentea*  
*Hypoxis* sp.  
*Ipomoea* spp.  
*Pachystigma pygmaea*  
*Pygmaeothamnus Zeyheri*  
*Scabiosa anthemifolia*  
*Senecio venosus*  
*Silene oliveriana*  
*Sphenostylis angustifolia*  
*Vernonia monocephala*

Here and there local patches of *Sphenostylis angustifolia*, *Pachystigma pygmaea* and *Pygmaeothamnus Zeyheri* are frequent.

(b) *Grassland on stony regions such as hill slopes.*

This type is very similar to the above type and probably incorporates all the species in it. The difference, however, is that the grass is much more bunchy in type, and there is a greater tendency towards local developments of certain species, as for instance, the occurrence of *Schizachyrium*, *Sporobolus centrifugus* and *Digitaria tricholuenoides* is locally frequent to locally abundant especially on the shales, whereas their occurrence is only occasional in the flatter regions with deeper soil. These stony regions appear very similar on the photo to undisturbed veld but may be recognised by changes in tint representing rock outcrops.

(c) *Grassveld on the site of some recent or remote disturbance* such as old cultivated lands, overstocked and trampled areas, for example veld in the neighbourhood of old native kraals, and old roads and paths.

(i) *Old Cultivated Lands.*

The comparative age of old cultivated lands can often be estimated by the composition of the grass and other species found on them. For example, recently cultivated ground will have an abundance of weeds, such as *Gnaphalium undulatum*, *Senecio laevigatus*, *Datura Stramonium*, *Gomphrena globosa*, *Amaranthus Thunbergii*, *Tagetes minuta*, grasses such as *Aristida barbicollis*, *Eleusine indica*, *Chloris virgata*, *Panicum laevifolium*, and if the land has been cultivated for some time there will be an abundance of *Cynodon Dactylon*.



*Cynodon Dactylon* is usually brought into cultivated land as seeds in manure, or else small existing patches of *Cynodon*, such as those on old termitaria are induced to spread by the methods of cultivation, for instance, rhizomes are broken up and dragged some distance by ploughing and harrowing, and these rhizomes take root and spread.

If *Cynodon* has not become well established on a land before it is left it is unlikely that it will ever spread profusely, but once it has become established it remains for a great length of time, perhaps as long as a hundred years. Aerial photographs are very useful in indicating the sites of cultivated lands, for even after periods of twenty years, plough marks, unnoticeable on the ground are distinctly discernable on photographs.

As the age of the disturbance increases, the early weeds and grasses tend to disappear, and give place, first to several species of *Eragrostis*, then to local patches of *Hyparrhenia hirta*, *Rhyncelytrum roseum* and *Cymbopogon plurinodis*, which in turn give place to plants such as *Schizachyrium semiberbe*, *Sphenostylis angustifolia*, and eventually, after a period of perhaps 50—150 years, the stage of undisturbed veld is reached again.

(ii) *Overstocked and Trampled Areas.*

This type shows as light or mottled patches on aerial photographs. On the ground, however, the grass is often cropped very short, bare spaces are numerous, and large local patches of *Zizyphus zeyheriana* are frequent. If the period of overgrazing and trampling is of some duration, there will be a marked influx of weeds, and fairly large patches of *Cynodon dactylon* will be evident.

(iii) *Areas on Sites of, or near old or recent Native Kraals.*

Kraals are easily recognised on the aerial photographs, for there are usually numerous large patches of *Cynodon dactylon* in or around the kraals, and these patches show as light, almost white areas on the photographs; very often even the outlines of the ruined walls can be seen. From the air it is difficult to discriminate between old and recent kraals, except that old kraals were, as a rule, built in the shelter of hills, and appear as groups of circular specks, whereas recent ones, are really not kraals but houses, and frequently appear singly, most often in the open veld.

(iv) *Old Roads and Paths.*

These, even when of great age, are distinctly defined on aerial photographs, and their sites are, as a general rule, marked by lines of tall *Hyparrhenia hirta* or *Schizachyrium semiberbe*.

## 2. PROTEA—OTHER SPECIES OPEN WOODLAND.

This type is very wide-spread, occurring on almost all types of formations, but appears to be most extensive in the Dolomite country, and on the Chert Conglomerate although it is also common on Polo Ground Quartzite. On the photographs *Proteas* appear as small black specks, fairly wide apart but very evenly distributed, of a more or less uniform size, and are generally located on the slopes or near the foot of a hill, but are seldom densely intermingled with other types of woodland.

The *Proteas* commonly grow in veld of the undisturbed or stony variety; *Protea caffra* is the commonest species found in this area.

## 3. ACACIA, RHUS, ROYENA—OTHER SPECIES SCRUB TYPES.

This type is often found in more protected places, such as sinkholes, the northern aspect of ridges, or very uneven stony country.

On aerial photographs clumps of this type of bush occur as large closely grouped black dots, when they occur on outcrops, or as one large black dot when they indicate sinkholes.

When a fair degree of efficiency has been attained in the use of these photographs, individual species such as *Olea verrucosa*, *Royena pallens*, etc., can be picked out with the aid of a lens, by the size, depth of colour and shape of the dots.

The common species belonging to this type are:—

### Grasses.

*Andropogon amplexans*  
*Cymbopogon plurinodis*  
*Cymbopogon excavatus*  
*Digitaria eriantha*  
*Eragrostis* spp.  
*Eustachys paspaloides*

*Hyparrhenia hirta*  
*Rhyncelytrum setifolium*  
*Setaria* spp.  
*Sporobolus* spp.  
*Themeda triandra*

### Other Angiosperms.

*Acacia caffra*  
*Acacia Karroo*  
*Acacia robusta*  
*Acalypha angustata*  
*Achyranthes aspera*  
*Asparagus* spp.  
*Aloe transvaalensis*  
*Brachylaena discolor*  
*Celtis kraussiana*  
*Clematis brachiata*  
*Cluytia pulchella*  
*Carissa arduina*  
*Chilianthus arboreus*  
*Cotyledon* sp.  
*Cussonia spicata*  
*Dombeya rotundifolia*  
*Ehretia hottentotica*  
*Euclea lanceolata*  
*Euclea undulata*  
*Fagara magalismontana*

*Gymnosporia buxifolia*  
*Haemanthus magnificus*  
*Heteromorpha arborescens*  
*Hypoxis* sp.  
*Kiggelaria africana*  
*Lantana salicifolia*  
*Olea verrucosa*  
*Pittosporum viridiflorum*  
*Plectronia mundtii*  
*Rhus discolor*  
*Rhus Gueinzii*  
*Rhus lancea*  
*Rhus* spp.  
*Royena pallens*  
*Royena microphylla*  
*Solanum nigrum*  
*Solanum sisymbriifolium*  
*Vangueria infausta*  
*Vellozia retinervis*  
*Zizyphus mucronata*

Apart from the type just described, scrub is found growing along the watercourses, the more important species of which are similar to the above, with the addition of *Buddleia salviifolia*, several species of *Cyperus*, *Rubus* sp., *Typha australis*, and *Phragmites communis*.

It is worthy of note that *Streptocarpus vandeurei* was found growing between some boulders of the Polo Ground Quartzites.

Communities of *Stoebe vulgaris* are common, and sometimes of fairly considerable extent. They usually denote the sites of overgrazed areas or old roads and paths, and sometimes of old cultivated lands. *Stoebe* communities are not clearly defined on aerial photographs, but present a somewhat smudgy mottled appearance. Possibly after some experience these localities could be recognised with a fair amount of accuracy.

### CONCLUSIONS.

In conclusion, with special reference to the area under discussion, the following facts are worthy of note :—

Aerial photographs are of considerable aid in Botanical survey when used as maps, for they give a bird's-eye view of the country under observation, and indicate the most tangible landmarks to work by. They are also of great value in indicating the localities of depressions such as *sinkholes*.

*Old lands* and other disturbed sites, difficult to discern on the ground, are clearly shown on the photographs by dark lines showing plough furrows, by an abrupt change in colour, or by a change in tint.

After some experience, different *Scrub Types* can be recognised by the *size* and *density* of the dark spots shown on the photographs. *Mixed and undisturbed veld* can be recognised as even, homogeneous coloured areas.

The use of aerial photographs facilitates Botanical survey so considerably, that an area which would otherwise take a long time to investigate may be done in great detail in a comparatively short time. The photographs have, however, certain drawbacks, the most important of which are :—

(1) On account of the changes which country undergoes from season to season and from year to year, the photographs should be used as soon as possible after they have been taken, or if this is impossible, during the *same season* the following year. Photographs taken in one season are not strictly accurate for use at other seasons, on account of veld changes, colour variations and so forth.

The photographs described in this paper were taken in March 1933, whereas investigation of the area which they covered was not begun

until May of 1936, and it was found that roads existing in 1936 were not shown ; also several seasonal changes such as colour were not registered, or *vice versa*.

(2) Another drawback may be cloud shadows on the photographs. These shadows may be so dark that they may tend to obscure the appearance of the country.

(3) The line of strike of a dyke can often be quite clearly discerned on a photograph, but is quite impossible to find on the ground, either from change of colour of the vegetation or any other way. This, however, though not of any significance to the botanist, is of great value to the geologist, as an aid towards finding localities and lines of strike of dykes.

(4) The adherence of certain vegetation types to certain geological strata was not found to exist to any appreciable extent in this area, though it was found that there was a tendency for types of vegetation to appear on the same aspects *fairly consistently*, e.g. *Protea*, etc. This fact, however, is dependent on a great number of factors, such as protection from wind, cold, fire, soil moisture and pH of the soil.

From the geological point of view (as has been proved many times), these photographs are invaluable.

After some experience certain vegetation types can be recognised on aerial photographs by the following methods :—

- (1) *Mixed veld*. This can be recognised by its even colour and homogeneous appearance.
- (2) *Old Ploughed Lands*. These are recognisable by their striated appearance caused by plough furrows and their regular outlines.
- (3) *Cynodon*. Patches are represented by whitish smudges.
- (4) *Protea—Other Species Open Woodland*. This is shown as stippling, the dots being very even in size and distribution.
- (5) *Scrub Types, Acacia Karroo, Acacia caffra*, etc. These are shown by dense or unevenly scattered accumulations of black dots of varying sizes.
- (6) *Sinkholes*. Are shown as one large dark spot.
- (7) *Stoebe vulgaris communities*. Are represented by a smudgy, mottled appearance.

#### SUMMARY.

1. Introduction in which is given a description of the circumstances under which the work was done.
2. The Geology of the region is described.
3. A description of the Topography of the region is given.



4. Descriptions with lists of plant names are given for each of the ecological types recognisable on the photographs.

5. Conclusions as to relative merits and demerits of aerial photographs as an aid to Botanical survey, are discussed.

#### ACKNOWLEDGMENTS.

The author is indebted to Dr. John Phillips, Professor of Botany at the University of the Witwatersrand, in whose Department and with whose guidance this work was done; to Captain C. R. Robbins and Mr. Williamson of the Aircraft Operating Company, who very kindly supplied the maps and aerial photographs required; to Mr. N. Thamm of the West Witwatersrand Areas, Ltd., a number of whose hints are embodied in this paper; and to Mr. R. Rose-Innes who assisted with the field work.

#### BIBLIOGRAPHY.

1. BEWS, J. W. (1918): "The Grasses and Grasslands of South Africa." Davis & Sons, Pietermaritzburg.
  2. BOURNE, R. (1934): "Regional Air Survey." Imperial Forest Institute, Oxford.
  3. BOURNE, R. (1930): "Air Survey within the Empire." Vol II. The Air Annual of the British Empire.
  4. BURTT DAVY, J.: "Flowering Plants and Ferns of the Transvaal." Longmans, Green & Co., London.
  5. NEL, L. T.; FROMMURZE, H. F.; WILLIAMS, J.; HAUGHTON, S. H.: and DU TOIT, A. L. (1935): "The Geology of Ventersdorp and adjoining Country." Govt. Printer, Pretoria.
  6. ROBBINS, C. R. (1934): "Northern Rhodesia, an experiment in Classification of Land, with the use of Aerial Photographs." Journ. Ecol., Vol. XXIII, No. 1, Feb. 1935.
-